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Principal Investigator:

D. C. Sun, Associate Professor
Department of Mechanical and Industrial Engineering
State University of New York at Binghamton
Binghamton, New York 13902-6000

NASA Technical Officer:

David E. Brewe
Vehicle Propulsion Directorate
Army Research Laboratory
Mail Stop 23-2
Lewis Research Center
Cleveland, Ohio 44135

Signature of P.I.: D C Sun

Date: JUL 24, 93

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BACKGROUND

According to the work plan, the first year is to be devoted to the analyses of the geometrical and kinematic properties of meshing and the load sharing of the contacting teeth, then the second year is to be devoted to the selection of a hydrostatic lubrication configuration on the gear surface and the analysis of the hybrid (hydrostatic and hydrodynamic) lubrication at the contact. The work in the first year, JAN 1 - DEC 31 1992, was summarized in an extensive status report in which the methodology of generating wormgear surfaces was developed and a double-enveloping wormgear type was selected and analyzed, whose geometrical parameters and dimensions were chosen basically in accordance with the AGMA gear standards. In January 1993 we made an oral presentation of the first year's work at the Army VPD. Several questions were raised after the presentation. Among them one concerned the necessity of following the AGMA standards in adopting the 20 deg normal pressure angle. It was felt that making the pressure angle on the loaded side of the tooth close to 0 deg would be more effective in producing the needed torque. In addition, it was suggested to explore the possibility of increasing the tooth depth. A larger tooth depth would provide a larger bearing area, hence a smaller unit load.

To respond to these suggestions, we modified the original work plan and directed our effort to the search of promising asymmetric tooth profiles. The present status report describes the findings from this effort.

Asymmetric Tooth Profiles

The advantage of using a smaller pressure angle on the loaded side of the tooth is to reduce the components of the contact force that do not contribute to the turning torque of the gear. To realize a smaller pressure angle, the base circle must be made correspondingly small. Hence, an asymmetric tooth profile possesses two base circles, a smaller one for the loaded side and a "regular" one for the reverse side. After considerable search, the following features were established:

1. The size of the base circle restricted the face width of the worm. To maintain the number of meshing teeth to be no less than six, the normal pressure angle could only be reduced to 8.5 deg, still far from the targeted 0 deg value.

2. To preserve a even distribution of contact lines, i.e. to allow most of the tooth surface to experience contact during the meshing, the apex angle of the generating plane need be changed to 7.5 deg.

3. The tooth depth could be increased, but not greatly. This was because a larger tooth depth would reduce the top thickness of the tooth, which would compromise the tooth strength.

4. Because the number of meshing teeth was reduced to six, the load level on each tooth was drastically increased.

The above features were based on the comparison with the previously studied symmetric tooth profile. The geometrical parameters and dimensions in this comparison were as given in the previous status report, except that the pitch diameter of the worm was changed to 200 mm.

We are ready to interact with the Army VPD for finalizing the choice of a desirable tooth profile and proceed with the planned lubrication analysis.

Tooth Profiles with Closed Contact Lines

We also started the search for a tooth profile that would feature closed contour contact lines. If this "wishful thinking" could be realized, the implementation of hydrostatic lubrication would become very easy. The idea was as follows:

1. The tooth profile would consist of two parts: an inner part lying closer to the tooth root and an outer part lying closer to the tooth top. The two parts are tangent to each other at their seam.

2. The modified form of the enveloping processes would be used.

3. The contact line on the inner part would concave outward, while that on the outer part would concave inward. The two contact lines would join each other and form a closed contour.

4. The region of the tooth surface enclosed by the contour would serve as the oil recess for hydrostatic lubrication.

This work is ongoing.